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(54) STRUCTURAL CELLULAR MATERIALS

(71) We, DUFAYLITE DEVELOPMENTS LIMITED, a British Company, of Cromwell Road, St. Neots, Cambridgeshire, (formerly Huntingdonshire), do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to structural honeycomb materials, and other structural cellular materials in which cells extending through the thickness direction of the material have their wall defined by strip material—e.g. eggbox structures.

When their cell walls are coated with an intumescent material, which foams on heating to fill the cells, such materials have proved effective in fire barrier devices. In their unheated state they offer only a low resistance to airflow, and are therefore used in the form of grids to provide automatic closing of ventilation apertures or ducting to resist the spread of fire.

In accordance wtih the present invention there is provided a fire barrier device which comprises a grid of the kind aforesaid and a surrounding metal frame for the mounting thereof, said frame defining an inwardly directed channel extending around the periphery of the grid and overlapping the peripheral regions of the faces of the grid, said peripheral regions nesting in said channel but being free from attachment thereto so that the peripheral regions are free to move relative to said frame under fire conditions.

The fire resistance of the structure formed by foaming and carbonisation of the intumescent material and carbonisation of the structural cellular material (usually formed of paper or cardboard) is found to be improved in some applications compared with previous arrangements, the process of fire-breakthrough following a modified pattern. It appears that mechanical factors, as well as attrition of the structure, have been significant in leading to break-through with prior devices.

By making the metal frame discontinuous in the thickness direction of the grid, the rapid transfer of heat past the periphery of the grid by thermal conduction may be substantially eliminated. In a preferred arrangement, the metal frame is provided in the form of a pair of separate parts one of which has a flange overlapping the peripheral regions of one face of the grid and the other of which has a flange overlapping the peripheral regions of the other face of the grid, said pair of separate parts being held spaced apart out of mutual thermal communication by the grid.

The metal frame provided in the form of a pair of separate parts, or which is otherwise discontinuous, may be held together simply by a surrounding strip of sheet material adhesively secured thereto. This arrangement gives a satisfactory device for installation in a ventilation opening in a generally fire-resistant partition wall, e.g. a wall formed of masonry. When cementing or otherwise securing the device in position, it is a simple matter to arrange that the parts of the frame are firmly located. Thus the strip of sheet material serves to provide a readily transported and installed device but is not relied upon after installation.

It has been found that the modified pattern of fire-breakthrough obtained with a device of the invention tends to involve first a failure of the grid in the region of the frame. This failure can be postponed, in accordance with a feature of the invention, by lining the metal frame with an intumescent material, conveniently applied as a preformed strip material, e.g. an intumescent putty carried by a fabric back-

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ing. Alternatively, an intumescent composition in the form of a putty or mastic may be applied directly to the frame, e.g. using an adhesive gun or brush. Especially good results are obtained if the intumescent material of the lining is positioned to lie over the peripheral regions of the faces of the grid within said channel. Having the intumescent material of the lining extend also across the base of the channel, and thus across the outer edge of the grid, is unnecessary in practice.

Further improvement is possible by sandwiching the grid between reinforcing members of metallic mesh material, and especially so when the reinforcing members are linked together through the cellular material such as by metal ties.

Advantageously such reinforcing members are held by their peripheries within the channel.

The following description, in which reference is made to the accompanying diagrammatic drawings showing preferred embodiments of the device is given in order to illustrate the invention.

In the drawings:

Figure 1 shows in perspective a first embodiment of the device fitted in a ventilation duct,

Figure 2 is a cross section taken at II-II of Fig. 1,

Figure 3 shows part of the grid of the embodiment of Fig. 1 in further detail and on an enlarged scale,

Figure 4 shows a second embodiment of the device in elevation,

Figure 5 is a cross section taken along V-V of Fig. 4,

Figure 6 shows a further embodiment in elevation, installed in a cylindrical duct,

Figure 7 is a cross section along VII-VII of Fig. 6,

Figure 8 is a perspective of a further embodiment,

Figure 9 shows a part of the embodiment of Fig. 8, in isolation on an enlarged scale, and

Figure 10 shows the device of Figs. 8 and 9 installed in an opening of a partition wall.

Fig. 1 shows a device according to the invention fitted within a ventilation duct 1 shown partly broken away for purposes of illustration. The device is formed of four metallic members 2 within which a grid of intumescent coated cured resinated impregnated kraft paper honeycomb material 3 has a push fit. In Fig. 1 the position of the honeycomb material is indicated by crossed lines. The cross-section of its cells is generally hexagonal as shown in Fig. 3. In Fig. 3 the walls of single thickness are shown at *A*, the walls of double thickness are shown at *B* and the intumescent coating is shown at *C*. Intumescent material expanded by heat to fill the cells is shown at *D*.

As will be seen from Fig. 2, the axial length of the cells is large compared with their cross-sectional dimensions.

The channel members are secured in position in the duct 1 by self-tapping screws 4.

Under fire conditions, the grid 3 is closed by the expansion of the intumescent material and the resulting structure carbonises. Members 2 are effective to prevent gaseous flow by-passing the structure before it finally yields. There is little tendency for thermal distortion of the ducting to load the carbonised structure.

Fig. 4 shows an elevation of a modified barrier in which the grid is sandwiched between wire mesh reinforcing members 5 which extend into the channels of the members 2.

Fig. 5 is a cross-section taken on line V-V of Fig. 4 and shows the manner in which the members 5 are secured together by wire ties 6 passed through the cells.

Fig. 6 is a cross-section of a circular duct provided with a circular grid 3′ of intumescent coated honeycomb material and Fig. 7 is a cross-section taken on line VII-VII of Fig. 6.

Grid 3′ and reinforcing wire mesh members 5 are positioned between a pair of metallic rings 61 and 62 of angle section, produced by metal spinning or rolling, which define an inwardly directed circumferential channel as shown. A gap 63 of ring 61 and a similar gap of ring 62, at the bottom of the duct where reduced fire resistance is best tolerated, facilitate installation and tend to relieve the rings 61 and 62 of stress when the duct is distorted by heat. Additionally, the gaps enable the rings to be sprung into tight contact with the duct, so tending to avoid having a circumferential gap. The outer surfaces of the rings may be coated with intumescent material for further security if required.

The rings are secured in place by screws or rivets 4. Alternatively, they may be secured between locating members, e.g. the angle-section rings 63 shown in broken lines in Fig. 7.

It is found that the wire resistance of a device of Figs 1 to 7 is improved by having the rivets, screws or other attachments displaced well away from the side from which fire is expected. To give improved resistance from both sides, two sets of attachments each displaced from the median plane may be provided—see Fig. 7. The attachments of one set are preferably staggered so that they lie peripherally between the members of the other set.

In the device of Fig. 8, the metal frame

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is formed in two sections 81 and 82 dimensioned to fit around the edges of grid 3 of intumescent coated resinated paper honeycomb whilst leaving a peripheral gap between the mutually facing edges 83 and 84 of their base parts. This gap prevents the rapid transfer of heat by thermal conduction from one section to the other. The two sections are held in position by a band 85 of self-adhesive film shown partly peeled-away in Fig. 8 for simplicity of illustration.

The flange parts 86, 87, 88 of the frame sections are mitred to meet as at 89 in Fig. 8. The base parts of the vertical members of the frame sections are continued beyond the mitred edges of the flange parts and bent perpendicularly inwardly, e.g. at 90 in Fig. 9, to fit within the ends of the base parts of the horizontal frame members where they are secured by spot welding. Preferred positions of the spot welds beneath band 85 are shown at 92 in Fig. 8.

On each face of the honeycomb grid 3 is a reinforcing member of non-woven wire mesh 5 formed of a set of parallel horizontal wires and a set of vertical wires superposed thereon and welded thereto at each intersection. The edges of the reinforcing members extend to within the frame sections and are welded in position by spot welds 95. It is not necessary for the pitch of welds 95 to be equal to the mesh size of the reinforcing members. In Fig. 8 only alternate vertical wires are shown to be welded.

At their inner faces the flange parts of the frame members are lined by thick strips 96 of intumescent coated resinated cardboard. These strips cover the edges of the wire mesh reinforcing members internally and have their inner faces in contact with the honeycomb slab.

The device of Fig. 8 is shown, in Fig. 10, fitted within an opening 99 of a concrete partition wall 101 and cemented in position as at 102. After installation, the cementing holds the frame part of the device together, i.e. the band 85 is relied upon only until the device has been fitted.

When fire conditions occur on one side of wall 101, hot gases passing through the device cause the intumescent coating of the honeycomb slab to swell, carbonise and stop the gaseous flow. The wire mesh reinforcing members prolong the integrity of the slab and the strips 96 foam and carbonise, especially on the fire-side of the device, substantially increasing the time to eventual break-through.

A device as shown in Fig. 8 may be produced in any desired reasonable size depending upon its intended purpose. When the size exceeds, say, 15 cm. overall in the vertical or horizontal direction, it is advantageous to fit wire ties as shown in Figs. 4 and 5. For large structures the ties are preferably distributed closer together at the top of the device than the bottom.

Devices as herein described preferably employ structural honeycomb material as the structural cellular material. It is advantageous to install them with the double-thickness walls of the honeycomb cells running vertically. Suitable labelling may be provided to show the preferred orientation at the time of installation. As will be appreciated a preferred device for a rectangular opening dimensioned $a \times b$ is different from that preferred for a rectangular opening dimensioned $b \times a$.

In the Complete Specification of our Patent Application No. 18867/75, Serial No[illegible] 1 500 913, we claim a fire barrier device which comprises a grid of the kind aforesaid, a frame bounding the grid and a pair of reinforcing members of metallic mesh material positioned one in contact with each face of the grid so that the grid is sandwiched therebetween.

WHAT WE CLAIM IS:—

1. A fire barrier device which comprises a grid of a structural cellular material having cells which extend through the thickness direction of the grid from face to face thereof and have their walls defined by strip material, said walls being coated with an intumescent material, and a surrounding metal frame for the mounting of the grid, said frame defining an inwardly directed channel extending around the periphery of the grid and overlapping the peripheral regions of the faces of the grid, said peripheral regions nesting in said channel but being free from attachment thereto so that the peripheral regions are free to move relative to said frame under fire conditions.

2. A device according to Claim 1 in which the metal frame is discontinuous in the thickness direction of the grid.

3. A device according to either of Claims 1 or 2 in which the metal frame is provided in the form of a pair of separate parts one of which has a flange overlapping the peripheral regions of one face of the grid and the other of which has a flange overlapping the peripheral regions of the other face of the grid, said pair of separate parts being held spaced apart out of mutual thermal communication by the grid.

4. A device according to either of Claims 2 or 3 in which the metal frame is held together by a surrounding strip of sheet material adhesively secured thereto.

5. A device according to any one of Claims 1 to 4 in which the metal frame is lined with an intumescent material.

6. A device according to Claim 5 in

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which the metal frame is lined with a strip material coated with an intumescent composition.

7. A device according to either of Claims 4 or 5 in which the intumescent material of the lining is positioned over said peripheral regions of said faces within said channel.

8. A device according to any one of Claims 1 to 7 in which the grid is sandwiched between reinforcing members of metallic mesh material.

9. A device according to Claim 8 in which the reinforcing members extend into the channel.

10. A device according to either of Claims 8 or 9 in which the grid is circular and the metal frame is formed with a circumferential gap.

11. A device according to any one of Claims 8 to 10 in which the reinforcing members are secured together by ties which extend through cells of the grid.

12. A fire barrier device substantially as hereinbefore described and illustrated by reference to Figs. 1 to 5, 6 or 7 of the accompanying drawings.

13. A fire barrier device substantially as hereinbefore described and illustrated by reference to Figs. 8 to 10 of the accompanying drawings.

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1 500 912 COMPLETE SPECIFICATION
3 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEET 1

Fig. 1.

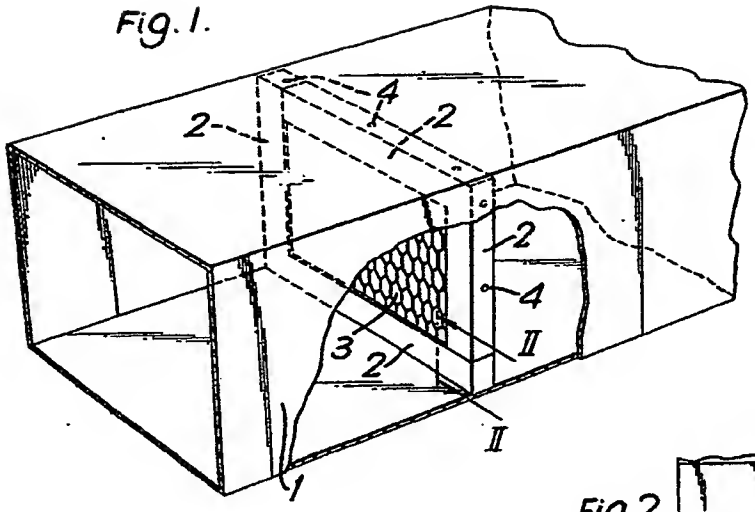


Fig. 2.

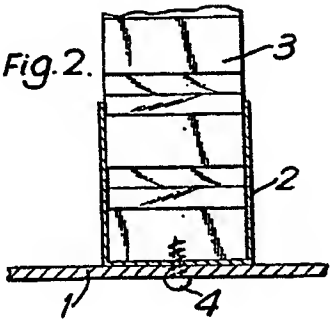


Fig. 3.

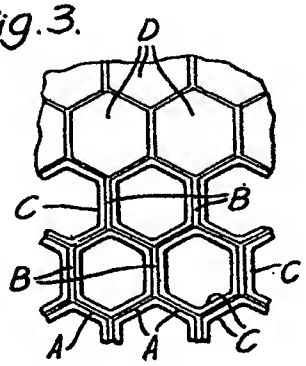
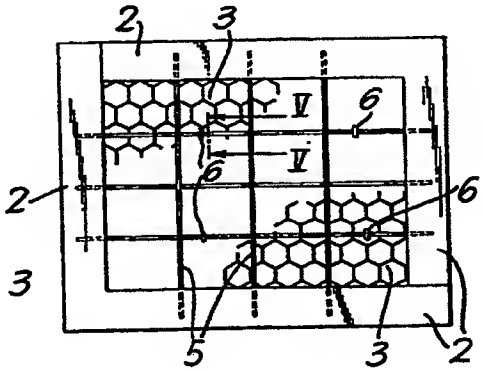


Fig. 4.



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3 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEET 2

Fig. 5.

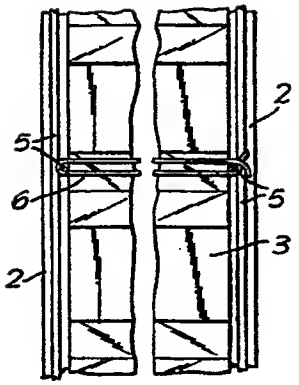

Fig. 6.

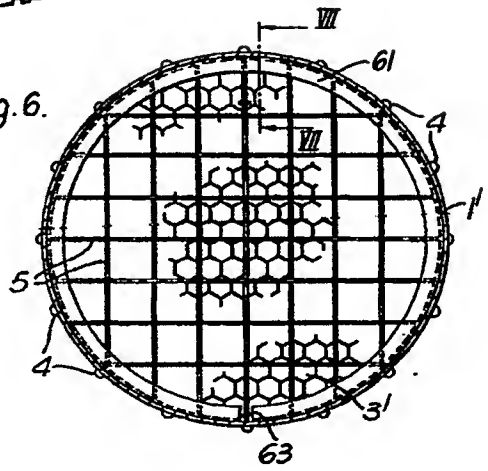

Fig. 7.

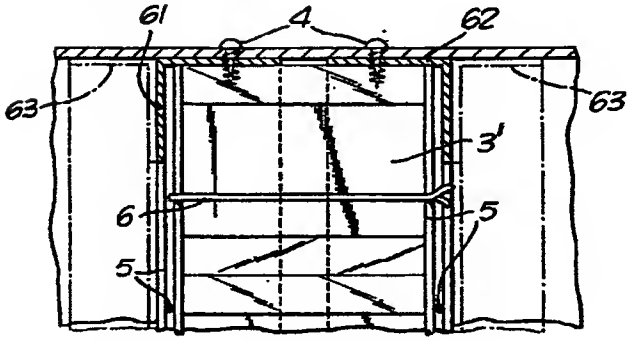

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Fig.8.

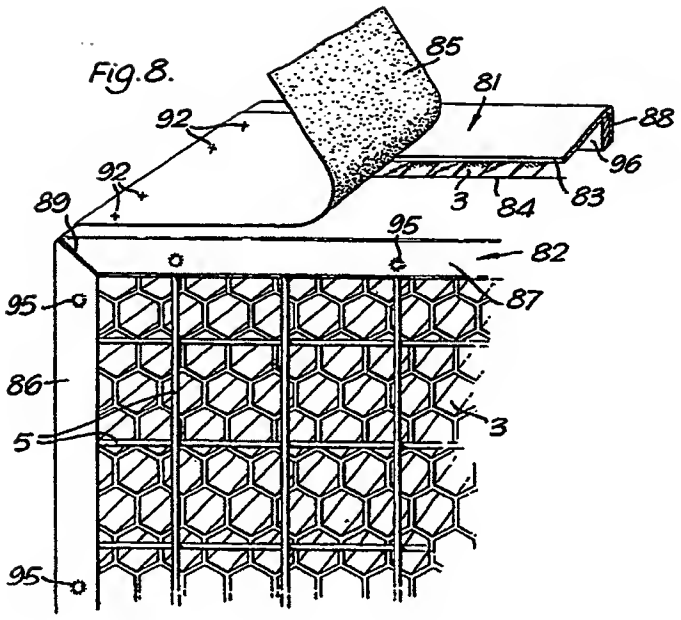


Fig.9.

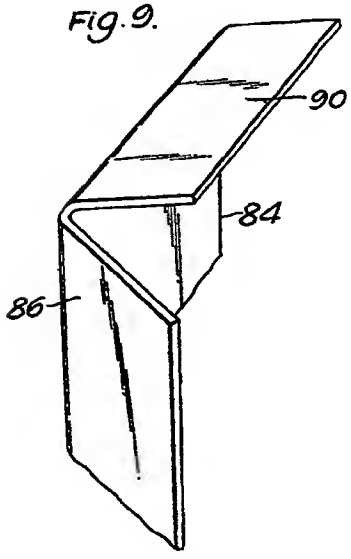
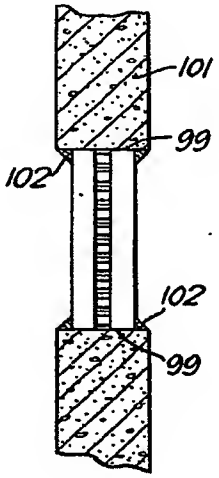


Fig. 10.



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